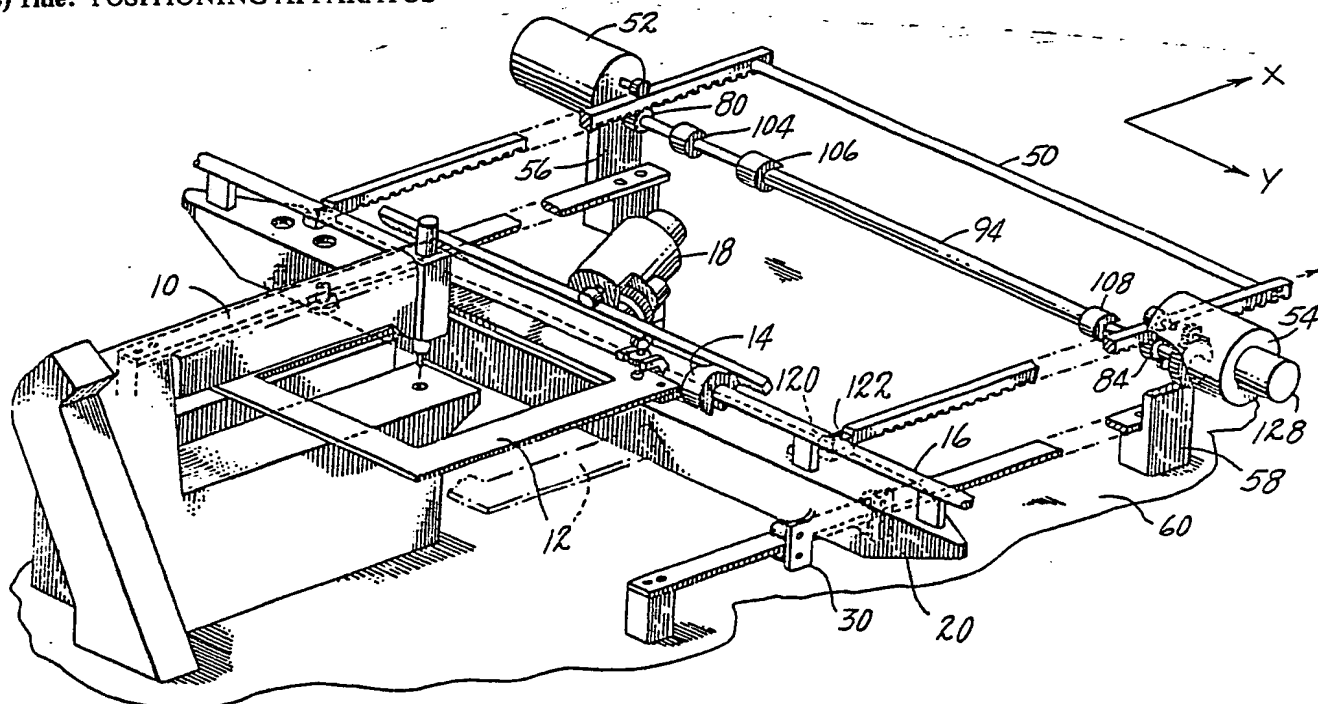




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(54) Title: POSITIONING APPARATUS**(57) Abstract**

An X-Y positioning apparatus having a dual drive arrangement for the X-direction of motion. The dual drive arrangement includes a pair of pinion gears (80, 84) engaging gear racks (46, 48) extending rearwardly from a frame member (20). A carriage (14) is mounted for movement along the frame member in a Y-direction. The pinion gears are joined together by a rigid coupling (110) which can be disengaged so as to allow for the adjustment and alignment of the X and Y directions of motion.

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Title: Positioning Apparatus

FIELD OF THE INVENTION

This invention relates to apparatus for positioning an article
5 relative to an operative tool. In particular, this invention relates
to the positioning of an article relative to the sewing needle of an
automatic sewing machine.

SUBSTITUTE SHEET



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BACKGROUND OF THE INVENTION

The need to position an article rapidly and accurately with respect to an operative tool is a basic requirement in today's automated machinery. For a programmable computer-controlled sewing machine, the workpiece must be quickly and accurately positioned relative to a reciprocating sewing needle. The actual movement of the workpiece must be accomplished during that portion of the reciprocating needle cycle when the needle is disengaged from the workpiece. As the size of the workpiece (which may in and of itself consist of a number of separate pieces to be joined together) increases, the problem of achieving the desired accuracy within the finite period of time allowed for positioning by the reciprocating needle becomes more difficult. The ever increasing weight of workpieces may pose special problems for a positioning apparatus designed to accommodate less heavy articles. For example, the structure of the positioning apparatus may be too flexible to accommodate heavier workpieces so as to result in vibration and excessive overshoot during rapid positioning movements.

One approach to the aforementioned problem of accurately positioning a heavy workpiece is to merely scale up the structure present in existing positioning apparatus. This however results in very large and heavy types of structure which even further add to the weight to be moved by a motorized drive source. This furthermore may result in apparatus that cannot be easily manufactured or thereafter adjusted.

It is an object of this invention to provide a positioning apparatus which rapidly and accurately positions relatively large and heavy pieces of work relative to an operative tool.

It is a further object of the invention to provide a lightweight
10 positioning apparatus capable of positioning large and heavy pieces of
work relative to a reciprocating sewing needle.

It is a still further object of this invention to provide positioning apparatus which can be easily adjusted and aligned.

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SUMMARY OF THE INVENTION

The above and other objects are achieved according to the present invention by providing a frame that is suspended above a pair of rail guides which define an X-direction of movement of the frame. A
5 carriage is mounted for movement on the frame in a Y-direction transverse to the X-direction of movement of the frame. The frame consists of a frame member extending laterally over the rail guides and having a pair of gear racks which extend rearwardly from the frame member. The gear racks are driven by a pair of rigidly coupled motors
10 having pinion gears which engage the gear racks. In accordance with the invention, the rigid coupling between the motors can be disengaged so as to allow for adjustment and alignment of the Y-axis carriage with respect to the X-axis rail guides to insure an accurate right angle between the two axes. In an alternative to the preferred
15 embodiment, only one motor is utilized to drive the pair of gear racks. This is accomplished by mounting a pinion gear at the far end of the aforementioned rigid coupling. The rigid coupling couples the thus mounted pinion gear with the pinion gear associated with the single motor. Adjustment of the Y-axis motion with respect to the
20 X-axis is accomplished in the same manner as that disclosed for the dual motor X-drive.



1 DESCRIPTION OF THE DRAWINGS

Figure 1 illustrates the positioning apparatus relative to a sewing machine head;

Figure 2 is another view of the positioning apparatus;

5 Figure 3 illustrates the gear drive associated with one of the
two dual motors;

Figure 4 is a detailed showing of the adjustable cross shaft coupling between the dual motor drive;

Figure 5 illustrates the alignment procedure for the positioning
10 apparatus;

Figure 6 illustrates a connection between certain elements present within the positioning apparatus; and

Figure 7 illustrates an alternative positioning apparatus to that disclosed in Figures 1-6.

1 DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to Figure 1, a sewing machine 10 is generally illustrated in conjunction with a pallet 12 which normally holds an article that is to be sequentially positioned underneath the needle of the sewing machine 10. The pallet 12 is removably mounted to a carriage 14 as shown. The carriage 14 is mounted for movement along the length of a cylindrical axis member 16. The cylindrical axis member 16 will be arbitrarily hereinafter referred to as the Y-axis of movement.

10 Referring to Figure 2, the motorized drive for the carriage 14 is seen to comprise a motor 18 mounted on a slant to a frame member 20. The motor 18 includes a pinion drive 22 that engages a gear rack 24 associated with the carriage 14. The gear rack 24 is slanted at the angle of mounting for the motor 18 so as to thereby accommodate the
15 pinion drive of the slanted motor.

The frame member 20 is seen to include four sets of downwardly extending rollers 28, 30, 32 and 34. The downwardly extending rollers 28 and 30 engage the top and bottom surfaces of a rail guide 36. The downwardly extending rollers 32 and 34 engage the top and bottom
20 surfaces of a rail guide 38. In this manner, the frame member 20 is stabilized at a vertical height above the rail guides 36 and 38 while at the same time being mounted for movement along these rail guides. The movement along the rail guides 36 and 38 will be hereinafter arbitrarily referred to as the X-axis of movement.

25 The frame member 20 also includes internally located roll guides 40 and 42. Each of these roll guides includes a roller such as 43 and 44 which engage the edges of the rail guide 38. It is to be noted that the engagement of the respective edges of rail guide 38 can be adjusted by vertical access holes going through the body of the frame
30 member 20 to the roll guides 40 and 42. In this regard, the shaft for the respective roller 43 is eccentrically mounted within the roll guide 42. A rotational adjustment of the roll guide 42 through the access hole in the frame member 20 causes the shaft for the roller 43

1 to move inward or outward with respect to the rail guide 38. In this manner the position of the roller 43 with respect to the rail guide 38 can be adjustably established.

A pair of gear racks 46 and 48 extend backwardly from attachment 5 points to the frame member 20. The ends of the gear racks 46 and 48 are connected by a bar 50. The gear racks 46 and 48 are driven by a pair of motors 52 and 54. The housings for the motors are attached to a pair of vertical supports 56 and 58 which extend from a common base 60 as shown in Figure 1. It is to be noted in Figure 1 that the 10 common base 60 is common to all principal elements of the positioning apparatus as well as the sewing machine 10.

Referring now to Figure 3, the mounting of the motor 52 to the vertical support 56 is illustrated in detail. An outer casing 62 of the motor is seen to be attached to a front casing 63 for the motor 15 via bolts such as 64 and 65. The front casing 63 is mounted to the vertical support 56 via a pair of bolts threadably received in the vertical support 56 as is illustrated by the dotted outline bolt 67. The motor 52 rotatably drives an output shaft 68 having a pinion 69 that engages a gear 70.

20 The gear 70 is affixed to a machined shaft 71 having various diameters so as to accommodate various elements press-fit thereon. An inner race of a ball bearing assembly 72 is press-fit onto the one end portion of the shaft 71. The inner race abuts a raised diameter portion of the shaft 71 which has the gear 70 press-fit thereon. The 25 outer race of the ball bearing assembly 72 rests against defined shoulders 74 of the casing 62 so as to rotatably support the shaft 71 within the outer casing 62. The shaft 71 is otherwise supported by a ball bearing assembly 75 having an inner race press-fit onto a shaft portion 76. The inner race of the bearing assembly 75 abuts a raised 30 diameter portion 77 of the shaft 71. The outer race of the bearing assembly 75 is preloaded towards the ball bearing assembly 72 by a spring 78 mounted within the front casing 63. It is hence to be appreciated that the shaft 71 rotates in response to a rotation of the

1 output shaft 68 of the motor 52. A pinion gear 80 affixed to a
portion 82 of the shaft 71 will also rotate in response to the
rotation of the output shaft 68 of the motor 52. The pinion gear 80
engages the gear rack 48 as shown. The gear rack 48 is maintained in
5 contact with the gear 80 by a roller 83. The rack 48 is caused to
move in a linear fashion in response to a rotational movement of the
gear 80.

It is to be appreciated that each of the motors 18, 52 and 54
include the same type of gear drive arrangement as is illustrated in
10 Figure 3. In this respect, each motor has a pinion gear such as the
pinion gear 22 for the motor 18, the pinion gear 80 for the motor 52
and a pinion gear 84 for the motor 54 which engageably drives a
respective rack. The casings for the motors 52 and 54 attach to the
respective vertical supports 56 and 58. On the other hand, the casing
15 for the motor 18 attaches to a mount 86 which establishes the angular
slant of the motor 18.

Referring again to Figure 3, it is seen that the shaft portion 82
has a flat end portion 88 as shown. Referring to Figure 4, the flat
end portion 88 is seen to engage a corresponding flat end 90 of a
20 shaft 92. The shaft 92 engages a shaft 94 having a slotted open end
96 which receives the circular end of the shaft 92. The opposite end
of the shaft 94 comprises a flat end 98 which mates with a flat end
100 of a shaft 102 extending from the pinion gear 84 associated with
the motor 54. It is to be noted that there are three separate
25 connections for the shafts 82, 92, 94 and 102. In each instance, a
split collar is used to secure the connection. In this regard, a
split collar 104 secures the connection between the flat end 90 and
the flat end 88 whereas a split collar 106 secures the coupling
between the slotted end 96 and the circular end of the shaft 92 and a
30 split collar 108 secures the flat ends 98 and 100 to each other. In
this manner, a rigid shaft coupling 110 is achieved between the two
drive motors 52 and 54.

As will now be explained, the particular configuration of the



1 rigid shaft coupling 110 allows for an adjustment of the overall
positioning apparatus and allows the two motor assemblies to be
uncoupled for maintenance without losing the relative timing of the
two pinion gears 80 and 84. This adjustment can be used to establish
5 a two axis perpendicularity of the positioning apparatus. Referring
to Figure 5, the positioning apparatus is illustrated with a right
angle square 112 clamped to the guide rail 38 by a C-clamp 114. An
edge sensor 116 is attached via a bracket 118 to the carriage 14. The
attachment of the bracket 118 to the carriage 14 can be a magnetic
10 attachment so as to be easily removable.

The alignment and adjustment of the positioning apparatus with
the edge sensor 116 and the clamped right angle square 112 proceeds in
the following manner. The rigid shaft coupling 110 is partially
assembled by positioning the mating flat ends 88 with 90 and 98 with
15 100. The split collars 104 and 108 are secured so as to thereby
establish the length of the rigid shaft coupling. The split collar
106 is left loose so that shaft 92 can be rotated relative to shaft
94. The gear rack 48 is also fixed by a clamp or other means so as to
not be movable in the X-direction. The pinion gear 84 associated with
20 the drive motor 54 is now rotated so as to establish a
perpendicularity of the Y-motion defined by the carriage 14 with
respect to the X-motion as defined by the guide 38. This
perpendicularity is checked by moving the carriage 14 along the
cylindrical axis 16 so as to thereby cause the edge sensor 116 to
25 track along the extending length of the right angle square 112. The
requisite perpendicularity is finally established for the positioning
apparatus when the pinion gear 84 has been appropriately rotated so as
to cause the edge sensor 116 to move along the right angle square 112
without deviation in the X-direction. The split collar 106 is now
30 tightened to prevent relative rotation of shafts 92 and 94.
This rigidly couples the pinion gears 80 and 84 and hence the motors
52 and 54 to each other.

It is to be noted that the aforementioned adjustment of the

1 positioning apparatus is facilitated through relatively loose
connections of the racks 46 and 48 to the frame member 20. The
adjustment is furthermore facilitated by a relatively loose threadable
engagement of the bar 50 at the ends of the racks 46 and 48. When the
5 requisite perpendicularity is achieved, the looseness in the
connections of the racks 46 and 48 to the frame member 20 is removed
as will now be explained.

The gear racks 46 and 48 are secured to the frame member 20 as
shown by way of example for gear rack 46 in Figure 6. Specifically,
10 the end of gear rack 46 is seen to have a pair of bolts 120 and 122
which extend down through a pair of holes 124 and 126. The bolts 120
and 122 threadably engage the frame member 20. In accordance with the
invention, the bolt 120 fits tightly within its hole 124 whereas the
hole 126 is larger than the thread diameter of the bolt 122. This
15 allows for the rack 46 to pivot about the bolt 120 during the
aforementioned adjustment of the positioning apparatus. A similar two
bolt connection allows for the same pivotal movement of the rack 48
with respect to the frame member 20. When the requisite
perpendicularity is established, the bolts associated with each rack
20 are all tightened down so as to prevent any further pivotal movement
of the racks with respect to the frame member 20.

The control for the X-drive is monitored by a control system
sensing the positional rotation of the motor 54. This is accomplished
by an encoder 128 attached in a well known manner to the rear of the
25 motor 54. The control of the Y-drive is similarly premised on sensing
the rotation of the motor 20 through an encoder 130 attached in a
well-known manner.

The positioning apparatus is now ready to execute motion in both
the X and Y directions. It is to be noted that the maximum movement
30 in the X-direction allows for the rear of the motor 20 to actually be
positioned over the rigid shaft coupling 110 as shown by the dotted
outline of the motor in Figure 2. This positioning of the motor is
facilitated by its slanted mounting which allows the rear of the motor



1 to clear the rigid shaft coupling 110.

Referring now to Figure 7, an alternative to the preferred embodiment of Figures 1-6 is illustrated. It is to be noted that like elements in Figure 7 are similarly labeled relative to their respective counterparts in Figures 1-6. The X-direction of motion in Figure 7 is seen to be governed by a single motor 54. This is in contrast to the dual motor drive arrangement consisting of motors 52 and 54 in Figures 1-6.

The single motor drive of Figure 7 includes respective pinion gears 80 and 84 mounted to the rigid coupling 110. The pinion gear 80 is now driven by the motor 54 through the rigid coupling 110. The shaft 82 associated with the pinion gear 80 is rotatably mounted within the vertical support 56 in a manner well known in the art. The gear rack 48 is maintained in contact with the pinion gear 80 by the roller 83 which is mounted to the vertical support 56. The pinion gear 80 will drive the gear rack 48 in the X-direction in response to the rotational drive of the motor 54. The pinion gear 84 will in like manner drive the gear rack 46 so as to thereby produce a dual drive for the frame 20. It is to be appreciated that the aligning procedure of the Y-drive with respect to the X-drive as outlined and discussed in Figure 6 is equally applicable to the apparatus of Figure 7. In this regard, the disassembly of the rigid shaft coupling 110 between the pinion gears 80 and 84 is the same. The racks 46 and 48 are furthermore adjustable in precisely the same manner as heretofore discussed.

From the foregoing, it is to be appreciated that a preferred embodiment has been disclosed for a positioning apparatus. It is to be appreciated that alternative apparatus may be substituted for elements of the preferred embodiment without departing from the scope of the present invention.

1 What is claimed is:

1. Apparatus for positioning a workpiece relative to a reciprocating sewing needle, said positioning apparatus comprising a frame 20 mounted for movement at a predefined height above a pair of guides, said frame having an axis of motion 16 defined thereon said axis of motion being transverse to the direction of motion of said frame and a carriage 14 mounted for movement along said axis of motion, said carriage including a holder 12 for carrying the article to be positioned relative to said sewing needle characterized by:
 - 10 a pair of gear racks 46, 48 connected to said frame and extending in the direction of movement of said frame; and drivers 80, 84 associated with each respective gear rack, for engageably driving said respective gear rack, so as to thereby provide a dual drive to the frame through said respective
 - 15 gear racks.
2. The positioning apparatus of claim 1 characterized by:
 - a coupling device 110 for rigidly coupling each of said drivers for engageably driving a respective gear rack so that
 - 20 each of said gear racks is driven the same amount.
3. The positioning apparatus of claim 2 wherein said drivers for engageably driving said respective gear racks comprises a pair of pinion gears 80, 84 mounted to either end of said rigid coupling
- 25 device.
4. The positioning apparatus of claim 3 characterized by:
 - at least one motor 54 connected to said rigid coupling device so as to drive said pair of gears mounted to either end of said rigid
 - 30 coupling means.
5. The positioning apparatus of claim 1 or 2 wherein said drivers for engageably driving said respective gear racks comprises a

1 pair of motors 52, 54 having respective pinion gears 80, 84 connected to said rigid coupling device, said pinion gears engaging said respective gear racks.

5 6. The positioning apparatus of claim 1-5 further characterized by the connections 120, 122, 124 and 126 of said gear racks with respect to said frame being adjustable so as to allow for an alignment of the axis of motion of said carriage with respect to the direction of motion of said frame.

10

7. The positioning apparatus of claim 3, 4, 5 or 6 wherein said rigid coupling device comprises:

15 a pair of shafts 82, 84 extending outwardly from said pair of pinion gears, said shafts each having flat surfaces 88, 100 extending for a predetermined amount along the length of the shaft from one end thereof;

20 at least one middle shaft 92, 94 having flat surfaces 90, 98 extending for a predetermined amount along the length of the middle shaft from each end, said flat surfaces of the middle shaft mating with the flat surfaces of said pair of shafts extending from said pinion gears; and

25 a pair of coupling collars 104, 108 which maintain the mating flat surfaces of said middle shaft in contact with the flat surfaces of said pair of shafts extending from said pinion gears.

25

8. The positioning apparatus of claim 7 wherein said middle shaft comprises:

30 a first (92) and second (94) shaft portion, said first shaft portion having an open end (96) which can loosely receive an end of said second shaft portion so as to thereby allow said first shaft portion to rotate relative to said second shaft portion; and

 a collar (106) for clamping the open end of said first shaft portion so as to thereby eliminate the relative rotation of said first

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1 shaft portion with respect to said second shaft portion.

SUBSTITUTE SHEET



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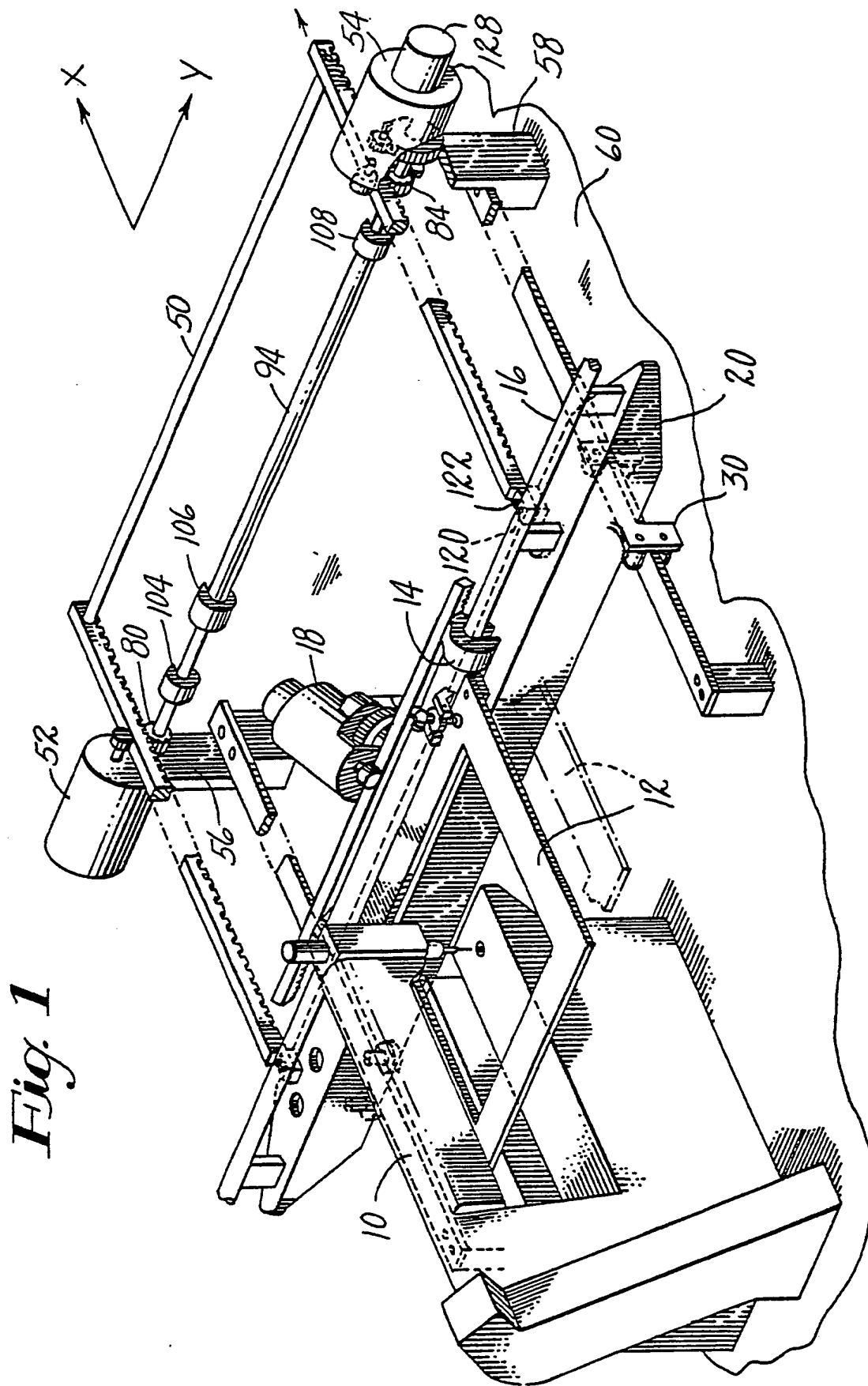


Fig. 2

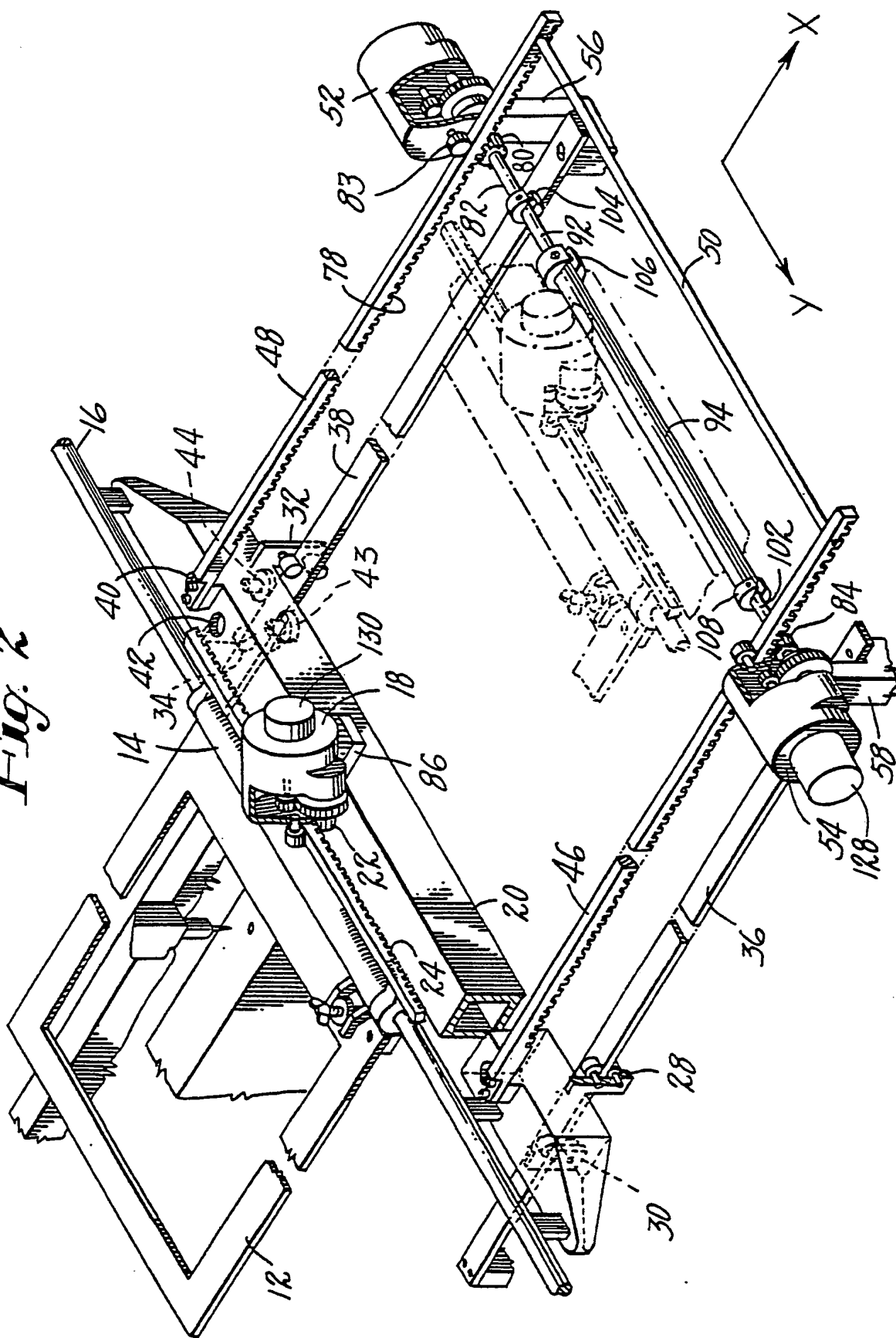
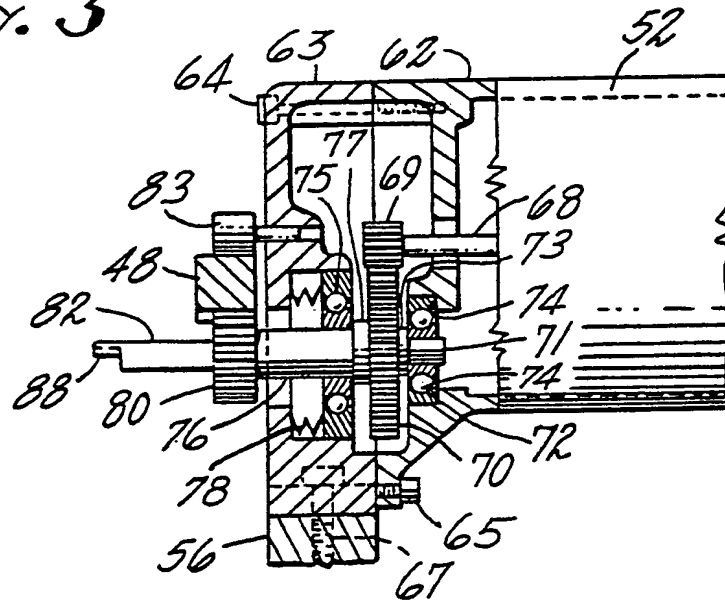
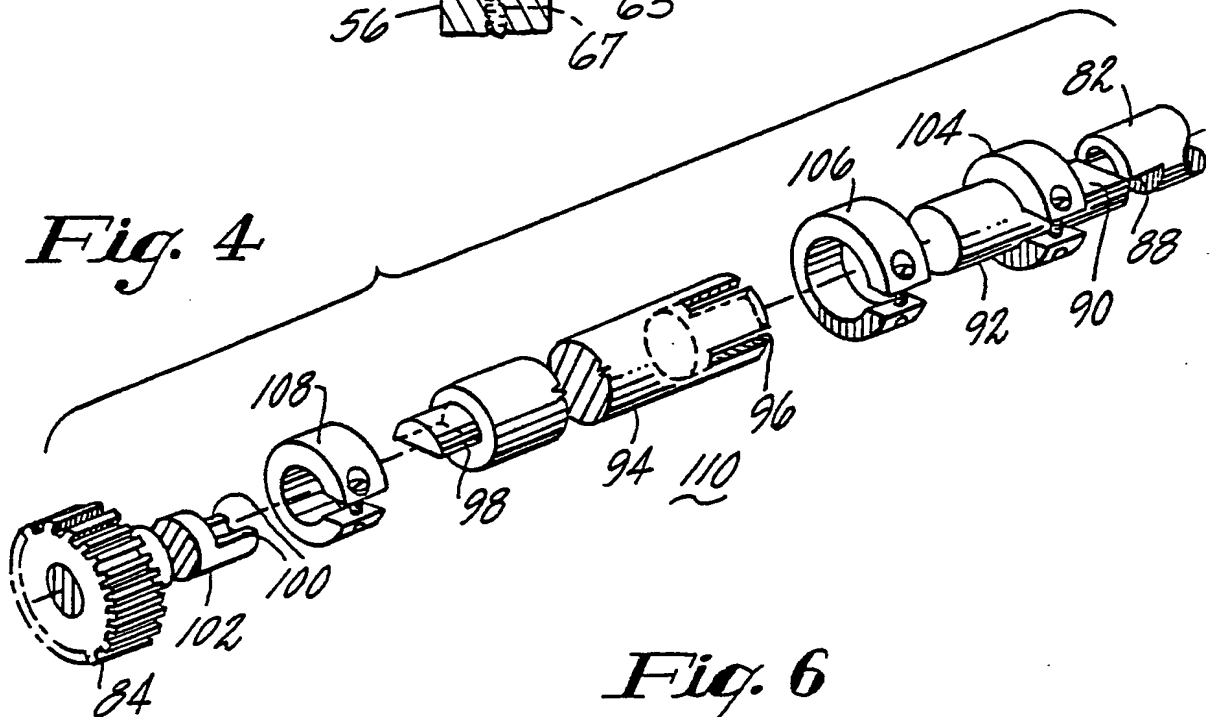
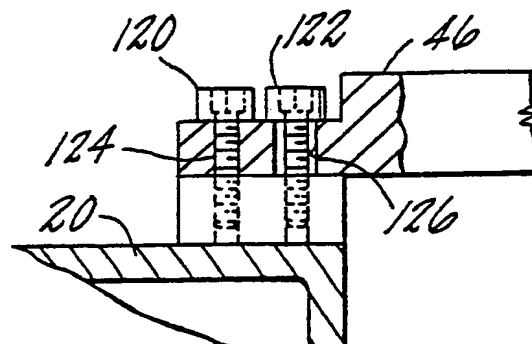
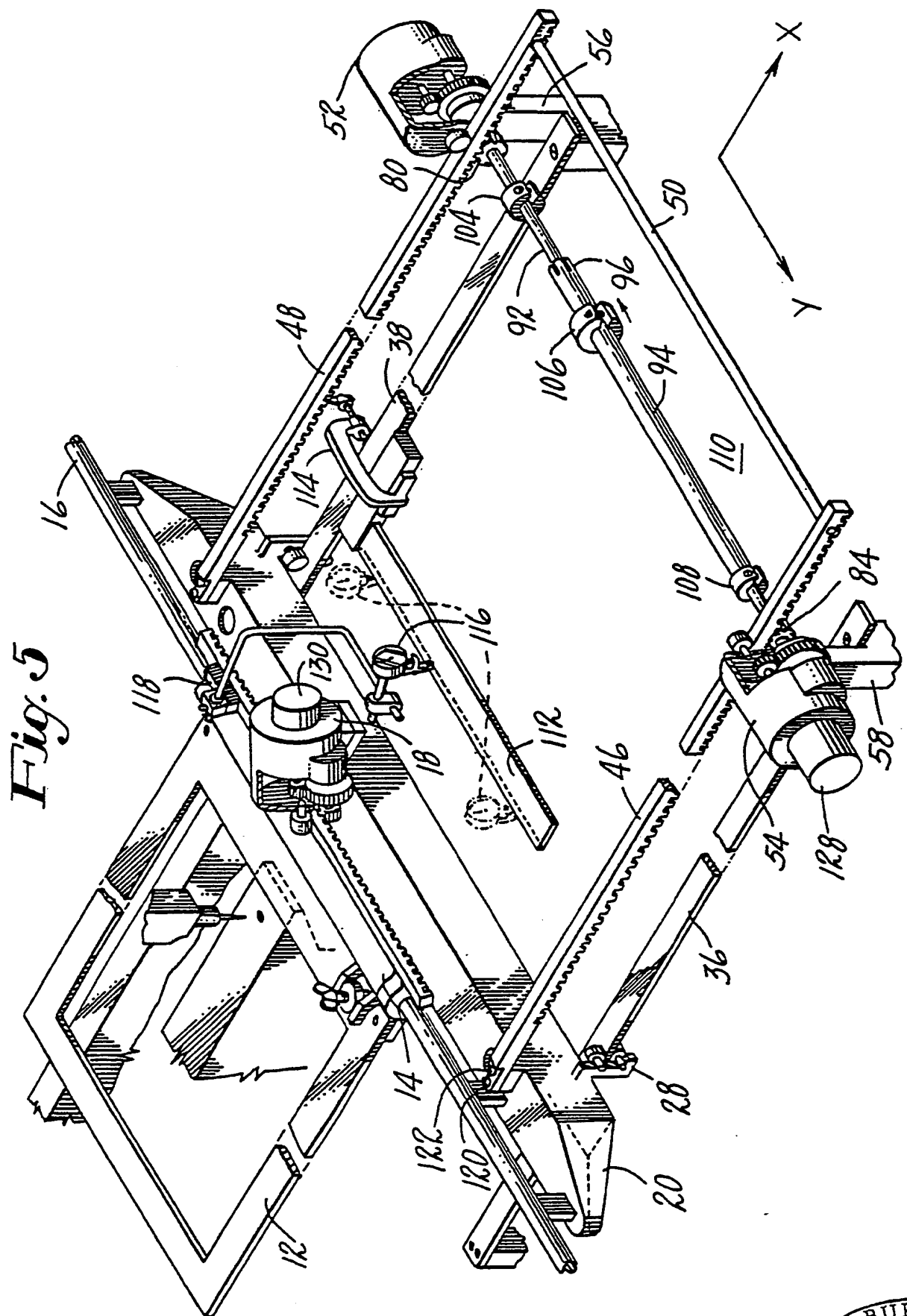
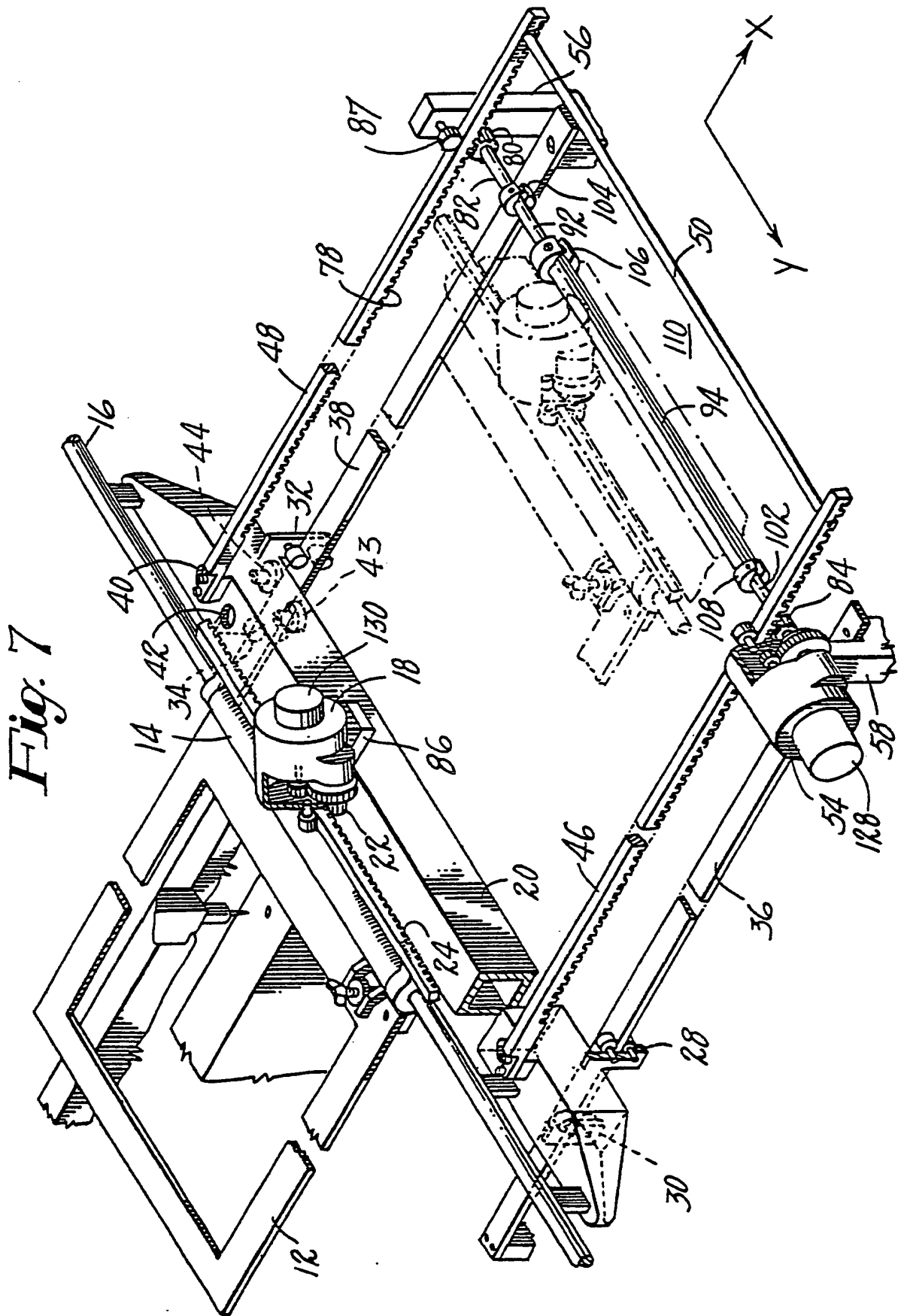


Fig. 3*Fig. 4**Fig. 6*

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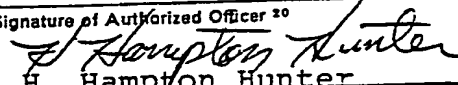


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INTERNATIONAL SEARCH REPORT

International Application No PCT/US 8 2 / 0 0 7 0 6

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) ³		
According to International Patent Classification (IPC) or to both National Classification and IPC		
INT. CL. ³ D 05 B 21/00, 27/00		
U.S. CL. 112/121.12, 308		
II. FIELDS SEARCHED		
Minimum Documentation Searched ⁴		
Classification System	Classification Symbols	
US	112/121.12, 121.15, 121.11, 2, 121.29, 308 309 101/287	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched ⁵		
III. DOCUMENTS CONSIDERED TO BE RELEVANT ¹⁴		
Category [*]	Citation of Document, ¹⁶ with indication, where appropriate, of the relevant passages ¹⁷	Relevant to Claim No. ¹⁸
X	US, A, 3,037,472 published 05 June 1962 Lockwood	1-8
X,P	US, A, 4,312,282 published 26 January 1982 Dorosz et al	1-8
X	US, A, 3,329,109 published 04 July 1967 Portnoff et al	1-8
X	US, A, 1,731,834 published 15 October 1929 Wheeler	1-8
A	US, A, 3,927,628 published 23 December 1975 Palmer	1-8
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IV. CERTIFICATION		
Date of the Actual Completion of the International Search ²	Date of Mailing of this International Search Report ²	
13 September 1982	17 SEP 1982	
International Searching Authority ¹	Signature of Authorized Officer ²⁰	
ISA/US	 H. Hampton Hunter	